

e-Ship: radiological transport assistant

Dr. Joseph Magill,
Nucleonica GmbH
Karlsruhe

nucleonica ... web driven nuclear science

Applications Data Knowledge My Preferences Print Networking Nuclear Science Help New Browser

e-Ship
radiological transport assistant

Getting started
Reference manual

Questions, remarks, suggestions can be posted in the [forum](#)

My Packages Edit Options Import Activity limits CERN file Sample packages About e-Ship

Selected columns of the package grid

General	ICRP	Swiss RPO	IAEA Transport	Nucleonica
<input type="checkbox"/> MatIndex	<input type="checkbox"/> e_{ing} (Sv/Bq)	<input checked="" type="checkbox"/> LE (Bq)	<input checked="" type="checkbox"/> A_1	<input checked="" type="checkbox"/> γ dose rate
<input checked="" type="checkbox"/> Mass	<input type="checkbox"/> e_{inh} (Sv/Bq)	<input checked="" type="checkbox"/> LA (Bq)	<input checked="" type="checkbox"/> A_2	
<input checked="" type="checkbox"/> Half-life	<input type="checkbox"/> E_{ing} (mSv)	<input checked="" type="checkbox"/> A (Bq) / LE _{abs} (Bq)	<input checked="" type="checkbox"/> Excepted	
<input checked="" type="checkbox"/> Decay modes	<input type="checkbox"/> E_{inh} (mSv)	<input checked="" type="checkbox"/> A(Bq/kg) / LE (Bq/kg)	<input checked="" type="checkbox"/> Exempt (Bq)	
		<input checked="" type="checkbox"/> A (Bq) / LA (Bq)	<input checked="" type="checkbox"/> Exempt (Bq/g)	
		<input type="checkbox"/> $h_{0.07}$ (μ Sv/hMBq) @ 10 cm	<input checked="" type="checkbox"/> A / A_2	
		<input type="checkbox"/> h_{10} (μ Sv/hMBq) @ 1 m	<input checked="" type="checkbox"/> A / Excepted	
		<input type="checkbox"/> H_{10} (μ Sv/h) @ 10 cm	<input checked="" type="checkbox"/> A(Bq) / Exempt(Bq)	
		<input type="checkbox"/> CA (Bq/m ²)	<input checked="" type="checkbox"/> A(Bq/g) / Exempt(Bq/g)	
		<input type="checkbox"/> CS (Bq/cm ²)		

Gamma dose rate calculation

Dosimetry parameters

Distance (cm):

Threshold (keV):

Shielding:

Thickness (cm):

Include Daughters: ☐

e-Ship report

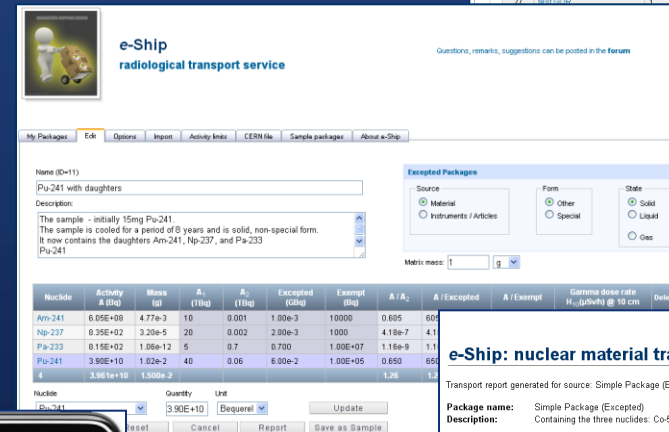
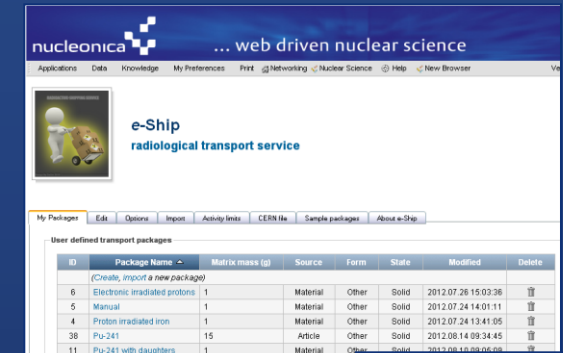
Report format

☒ HTML

☐ PDF

e-Ship: radiological transport assistant

- What is e-Ship?
- Background information on nuclear transports
- e-Ship user interface:
 - My Packages
 - Edit, Report
 - Options
 - Import
 - Sample packages
- My 1st packages



e-Ship: nuclear material transport report

Transport report generated for source: Simple Package (Exempted) by maglight on Aug 30, 2012 14:02:31

Package name: Simple Package (Exempted)
Description: Containing the three nuclides: Co-57, Co-58, Fe-59
Source: Material, Other form, Solid
Host material mass: 1 g

Source characterisation

Nuclide	Half-life	Mass (g)	Activity (Bq)	Heat (W)	Gamma dose rate H _{0.1} (μSv/h) at 10 cm
Co-57	271 d	3.84e-11	1.20e+4	2.76e-10	2.52e-2
Co-58	70.8 d	1.06e-11	1.24e+4	2.00e-9	1.82e-1
Fe-59	44.5 d	5.43e-11	1.00e+5	2.09e-8	1.75e+0
Total3		1.03e-10	1.24e+5	2.32e-8	1.96e+0

Package characterisation

Nuclide	Activity (Bq)	Exempt (Bq)	Exempt (TBq)	Exempt (gBq)	A ₂ (TBq)	A / Exempt (TBq)	A/D _{ex} (gBq)	A ₂ (TBq)	A / A ₂
Co-57	1.20e+4	1.00e+6	1.00e+1	1.00e+1	1.20e-2	1.20e+2	1.20e-2	1.20e-9	1.20e+9
Co-58	1.24e+4	1.00e+6	1.00e+1	1.00e+1	1.24e-2	1.24e+3	1.24e-5	1.24e-8	1.24e+8
Fe-59	1.00e+5	1.00e+6	1.00e+1	9.00e-1	9.00e-1	1.00e+4	1.11e-4	1.11e-7	1.11e+7
Total3	1.24e+5				1.24e-1	1.11e+4	1.25e-4	1.25e-7	

Exempted Package

The total dose rate at surface should be < 5μSv/h; calculated γ dose rate at 10 cm = 1.96e+0 μSv/h. If the surface gamma dose rate is ≥ 5μSv/h you should use a Type A package.

Aug 30, 2012 14:02:31



1. What is e-Ship?

e-Ship (electronic Shipment) is a software program for calculating radiological characteristics of packages for the shipment of radioactive material in accordance with ADR/IATA/IAEA transport regulations. The program also allows the user to estimate the radiological impact of the shipment in the event of a release of the radioactivity into the environment. For this purpose data such as the inhalation dose, ingestion dose, external radiation dose (ambient dose equivalent rate, etc.) are given.


The program has been developed jointly by CERN and Nucleonica.



2. Background information on nuclear transports

- Each year about 10 million packages of radioactive materials are transported worldwide by land, sea and air.
- Radionuclides are used for a variety of purposes e.g. in nuclear medicine, materials testing, oil exploration etc.
- For these purposes radioactive materials must be packaged and transported to the location of interest. Before these materials can be shipped, care must be taken that the shipping regulations have been strictly followed.
- The purpose of these regulations, of course, is to ensure safety by containing the radioactivity to make sure that there is no negative effect on the environment, to control the radiation emitted from the package, make sure that nuclear fission criticality conditions cannot be met, and to dissipate any heat generated within the package.
- Full details are given in the Nucleonica Wiki page on e-Ship

[help page](#) [discussion](#) [edit](#) [history](#) [delete](#)



navigation

- [Main Page](#)
- [Help](#)
- [Glossary](#)
- [Element Information](#)
- [ReadingRoom](#)
- [Gallery of Nuclear Science](#)
- [Weblinks](#)
- [Karlsruhe Nuclide Chart](#)
- [Premium Membership](#)

support

- [Training Courses](#)
- [Case Studies](#)
- [Nucleonica Support](#)

tools

- [Recent changes](#)
- [Random page](#)

search

toolbox

- [What links here](#)
- [Related changes](#)
- [Upload file](#)
- [Special pages](#)
- [Printable version](#)
- [Permanent link](#)

Help:E-Ship

Contents [\[hide\]](#)

- 1 [Introduction](#)
- 2 [A₁ and A₂ Values](#)
 - 2.1 [Example](#)
 - 2.2 [Transport Index](#)
- 3 [Classification of Packages](#)
 - 3.1 [Classification as an Excepted Package](#)
 - 3.2 [Classification as an Industrial Package](#)
 - 3.3 [Classification as a Type A package](#)
 - 3.3.1 [Activity Limits for Unknown Nuclides](#)
- 4 [Radiation and Contamination Limits](#)
 - 4.1 [Package Radiation Limits](#)
 - 4.2 [Package Contamination Limits](#)
 - 4.3 [Package Labels](#)
- 5 [e-Ship Web Application](#)
 - 5.1 [What is e-Ship?](#)
 - 5.2 [e-Ship User Interface](#)
 - 5.3 [My Packages](#)
 - 5.3.1 [Edit](#)
 - 5.3.2 [Report](#)
 - 5.4 [Options](#)
 - 5.4.1 [General](#)
 - 5.4.2 [ICRP](#)
 - 5.4.3 [Swiss RPO](#)
 - 5.4.4 [IAEA Transport](#)
 - 5.5 [Import](#)
 - 5.6 [Activity limits](#)
 - 5.7 [Sample Packages](#)
 - 5.8 [My 1st Packages](#)
- 6 [References](#)

Introduction

Each year about 10 million packages of radioactive materials are transported worldwide by land, sea and air. Radionuclides are used for a variety of purposes e.g. in nuclear medicine, materials testing, oil exploration etc. For these purposes radioactive materials must be packaged and transported to the location of interest. Before these materials can be shipped, care must be taken that the shipping regulations have been strictly followed. The purpose of these regulations, of course, is to ensure safety by containing the radioactivity to make sure that there is no negative effect on the environment, to control the radiation emitted from the package, make sure that nuclear fission criticality conditions cannot be met, and to dissipate any heat generated within the package.

e-Ship user interface: My Packages

nucleonica ... web driven nuclear science

Applications Data Knowledge My Preferences Print Networking Nuclear Science Help New Browser

e-Ship
radiological transport assistant

Help

Getting started
Reference manual
Questions, remarks, suggestions can be posted in the **forum**

Main tabs

My Packages Edit Options Import Activity limits CERN file Sample packages About e-Ship

Package details

My packages

User defined transport packages

Package Name	Host mass (g)	Source	Form	State	Activity reported	last Modified	Download	Delete
(Create, import a new package)								
Simple Package	1	Material	Other	Solid	2012.08.21 10:19:05	2012.08.21 16:00:16		
My 1st Package (Type A)	50	Material	Other	Solid	2012.08.21 10:17:30	2012.08.21 16:00:02		
My 1st Package (exempted)	150	Material	Other	Solid	2012.08.21 10:16:21	2012.08.21 15:59:47		
My 1st Package (excepted)	50	Material	Other	Solid	2012.08.21 10:17:03	2012.08.21 15:59:36		
Manual	1	Material	Other	Solid	2012.08.15 11:09:27	2012.08.21 16:00:27		
Irradiated sample using 26 GeV protons	1	Material	Other	Solid	2012.05.24 08:00:00	2012.08.21 15:59:16		
Irradiated sample (iron)	1	Material	Other	Solid	2012.02.27 08:00:00	2012.08.21 15:59:02		
Total: 7								

e-Ship user interface:

Edit

nucleonica ... web driven nuclear science

Applications Data Knowledge My Preferences Print Networking Nuclear Science Help New Browser Version: 2

e-Ship
radiological transport assistant

Getting started
Reference manual

Questions, remarks, suggestions can be posted in the [forum](#)

Package description

My Packages Edit Options Import Activity limits CERN file Sample packages About e-Ship

Name (ID=109)
Simple Package (Excepted)

Description:
Containing the three nuclides: Co-57, Co-58, Fe-59.

Activity reported: 2012.08.10 08:00:00

Package characteristics

Source
☒ Material
☐ Instruments / Articles

Form
☒ Other
☐ Special

State
☒ Solid
☐ Liquid
☐ Gas

Host material: 1 g

Nuclide	Activity A (Bq)	A ₁ (TBq)	A ₂ (TBq)	Excepted (GBq)	Exempt (Bq)	Exempt (Bq/g)	A / A ₂	A / Excepted	A (Bq) / Exempt (Bq)	A (Bq/g) / Exempt (Bq/g)	Delete
Ni-57	1.20e+4	0.1	0.02	2.00e-2	10000	10	6.00e-7	6.00e-4	1.20	1.20e+3	
Co-58	1.24e+4	1	1	1.00	1.00E+06	10	1.24e-8	1.24e-5	1.24e-2	1.24e+3	
Fe-59	1.00e+5	0.9	0.9	0.900	1.00E+06	10	1.11e-7	1.11e-4	0.100	1.00e+4	
Total: 3	1.244e+5						7.23e-7	7.23e-4	1.31	1.24e+4	

Nuclide: Fe-59 Quantity: 1.00E+05 Unit: Becquerel

Update

Save Package Reset Cancel Report

Transport report

nucleonica

e-Ship user interface: Report

e-Ship: nuclear material transport report



Transport report generated for source: Simple Package (Excepted) by magilltest on Aug 30, 2012 14:02:31

Package name: Simple Package (Excepted)
Description: Containing the three nuclides: Co-57, Co-58, Fe-59.
Source: Material, Other form, Solid
Host material mass: 1 g

Source characterisation

Nuclide	Half-life	Mass (g)	Activity (Bq)	Heat (W)	Gamma dose rate $H_{10}(\mu\text{Sv/h})$ at 10 cm
Co-57	271 d	3.84e-11	1.20e+4	2.76e-10	2.52e-2
Co-58	70.8 d	1.05e-11	1.24e+4	2.00e-9	1.82e-1
Fe-59	44.5 d	5.43e-11	1.00e+5	2.09e-8	1.75e+0
Total:3		1.03e-10	1.24e+5	2.32e-8	1.96e+0

Package characterisation

Nuclide	Activity (Bq)	Exempt (Bq)	Exempt (Bq/g)	Excepted (GBq)	A ₂ (TBq)	A Exempt	A(Bq/g) Exempt(Bq/g)	A Excepted	A A ₂
Co-57	1.20e+4	1.00e+6	1.00e+2	1.00e+1	1.00e+1	1.20e-2	1.20e+2	1.20e-6	1.20e-9
Co-58	1.24e+4	1.00e+6	1.00e+1	1.00e+0	1.00e+0	1.24e-2	1.24e+3	1.24e-5	1.24e-8
Fe-59	1.00e+5	1.00e+6	1.00e+1	9.00e-1	9.00e-1	1.00e-1	1.00e+4	1.11e-4	1.11e-7
Total:3	1.24e+5					1.24e-1	1.14e+4	1.25e-4	1.25e-7

Excepted Package

The total dose rate at surface should be < 5μSv/h: calculated γ dose rate at 10 cm = 1.96e+0 μSv/h.
If the surface gamma dose rate is ≥ 5μSv/h you should use a Type A package.

Aug 30, 2012 14:02:31

e-Ship user interface: Options

Four main categories of Options:

- General (Half-lives, decay modes, etc.)
- ICRP (dose coefficients, etc.)
- Swiss RPO (h(0.07), h(10) etc.)
- IAEA Transport (A_1 , A_2 , etc.)

nucleonica  ... web driven nuclear science

Applications Data Knowledge My Preferences Print Networking Nuclear Science Help New Browser

 **e-Ship**
radiological transport assistant

Quest

My Packages Edit **Options** Import Activity limits CERN file Sample packages About e-Ship

Selected columns of the package grid


General	ICRP	Swiss RPO	IAEA Transport	Nucleonica
<input type="checkbox"/> MatIndex	<input type="checkbox"/> e_{ing} (Sv/Bq)	<input checked="" type="checkbox"/> LE (Bq)	<input checked="" type="checkbox"/> A_1	<input checked="" type="checkbox"/> γ dose rate
<input checked="" type="checkbox"/> Mass	<input type="checkbox"/> e_{inh} (Sv/Bq)	<input checked="" type="checkbox"/> LA (Bq)	<input checked="" type="checkbox"/> A_2	
<input checked="" type="checkbox"/> Half-life	<input type="checkbox"/> E_{ing} (mSv)	<input checked="" type="checkbox"/> A (Bq) / LE_{abs} (Bq)	<input checked="" type="checkbox"/> Excepted	
<input checked="" type="checkbox"/> Decay modes	<input type="checkbox"/> E_{inh} (mSv)	<input checked="" type="checkbox"/> A (Bq/kg) / LE (Bq/kg)	<input checked="" type="checkbox"/> Exempt (Bq)	
		<input checked="" type="checkbox"/> A (Bq) / LA (Bq)	<input checked="" type="checkbox"/> Exempt (Bq/g)	
		<input type="checkbox"/> $h_{0.07}$ (μ Sv/h/MBq) @ 10 cm	<input checked="" type="checkbox"/> A / A_2	
		<input type="checkbox"/> h_{10} (μ Sv/h/MBq) @ 1 m	<input checked="" type="checkbox"/> A / Excepted	
		<input type="checkbox"/> H_{10} (μ Sv/h) @ 10 cm	<input checked="" type="checkbox"/> A (Bq) / Exempt(Bq)	
		<input type="checkbox"/> CA (Bq/m ³)	<input checked="" type="checkbox"/> A (Bq/g) / Exempt(Bq/g)	
		<input type="checkbox"/> CS (Bq/cm ²)		

e-Ship user interface: Import


Before a user can upload his/her own nuclide datasets, some rules have to be observed for the data format in these files.
The following delimiters are allowed: Comma , Semicolon ; Colon : Pipe | Octothorpe # TAB

The files can be created for example in a spreadsheet, but must be saved as csv files. In the example shown, the nuclide name together with the nuclide activity is shown with a comma , as delimiter. Currently only the activity can be accepted as input.

CERN .txt files: It is also possible to upload dedicated format CERN gamma spectrum files

... web driven nuclear science

ApplicationsDataKnowledgeMy PreferencesPrintNetworkingNuclear ScienceHelpNew Browser



e-Ship
radiological transport assistant

Getting started
Reference manual
Questions, remarks, suggestions can be posted in the forum

My PackagesEditOptions**Import**Activity limitsCERN fileSample packagesAbout e-Ship

Browse a file to be imported:

Import / Upload files:

- CSV: consisting of rows with at least (see example file below)
 - Nuclide name (e.g.: Co-60), Activity (in Bq)
- TXT: only for special CERN spectrum file format

Decimal separator

☒ Period 1/2 = 0.5

☐ Comma 1/2 = 0,5


File to be imported:

Nuclide,	Activity (Bq)
Co-60,	1.5e6
Cs-137,	1000
I-123,	20000
Tc-99m,	3.7e10


e-Ship user interface: Activity limits (IAEA)

The Activity limits tab contains the A1 and A2 values together with the activity concentration for exempt material (Bq/kg) and the activity limit for an exempt consignment (Bq). In addition a brief description and notes are given.

Care must be exercised when using nuclides in packages which are not in the IAEA Activity limits table. When a nuclide has been added to the package, it should be checked in the Activity limit tab to see if there is an entry. If there is no entry, this means that it is an unknown nuclide. In this case, the user must look up the datasheets for the appropriate nuclear data .

... web driven nuclear science

ApplicationsDataKnowledgeMy PreferencesPrintNetworkingNuclear ScienceHelpNew Browser



e-Ship

radiological transport assistant

This is a *beta* version of the new web application e-Ship.
Please report errors to info@nucleonica.com.

My PackagesEditOptionsImportActivity limitsCERN fileSample packagesAbout e-Ship


Nuclide ▾	Half-life	A1 (TBq)	A2 (TBq)	Activity concentration for exempt material (Bq/g)	Activity Limit for an exempt consignment (Bq)
55 Cs131	9.69 d	30	30	1.00E+03	1.00E+06
55 Cs129	1.342 d	4	4	1.00E+02	1.00E+05
24 Cr51	27.703 d	30	30	1.00E+03	1.00E+07
27 Co60	5.271 y	0.4	0.4	1.00E+01	1.00E+05
27 Co58m	8.9 h	40	40	1.00E+04	1.00E+07
27 Co58	70.86 d	1	1	1.00E+01	1.00E+06
27 Co57	271.80 d	10	10	1.00E+02	1.00E+06
27 Co56	77.31 d	0.3	0.3	1.00E+01	1.00E+05
27 Co55	17.53 h	0.5	0.5	1.00E+01	1.00E+06
96 Cm248	340 ky	0.02	0.0003	1.00E+00	1.00E+03
96 Cm247	16.0 My	3	0.001	1.00E+00	1.00E+04
96 Cm246	4.73 ky	9	0.0009	1.00E+00	1.00E+03
96 Cm245	8.5 ky	9	0.0009	1.00E+00	1.00E+03
96 Cm244	18.0 y	20	0.002	1.00E+01	1.00E+04
96 Cm243	30 y	9	0.001	1.00E+00	1.00E+04
96 Cm242	162.93 d	40	0.01	1.00E+02	1.00E+05
96 Cm241	32.8 d	2	1	1.00E+02	1.00E+06
96 Cm240	27 d	40	0.02	1.00E+02	1.00E+05
17 Cl38	37.2 m	0.2	0.2	1.00E+01	1.00E+05
17 Cl36	301.0 ky	10	0.6	1.00E+04	1.00E+06




e-Ship user interface: Sample Packages

The Sample packages tab contains a list of pre-defined sample packages.

By transferring these packages to the users own My Packages, sample packages are immediately available for testing.

... web driven nuclear science

ApplicationsDataKnowledgeMy PreferencesPrintNetworkingNuclear ScienceHelpNew BrowserVersion: 2012.08.28











e-Ship
radiological transport assistant

[Getting started](#)
[Reference manual](#)
[Questions, remarks, suggestions can be posted in the forum](#)

My PackagesEditOptionsImportActivity limitsCERN fileSample packagesAbout e-Ship

Predefined transport packages

Select	Package Name ^	Host mass (g)	Source	Form	State	Activity reported	last Modified	Delete
<input type="checkbox"/>	Irradiated sample (iron)	1	Material	Other	Solid	2012.02.27 08:00:00	2012.08.22 11:46:31	
<input type="checkbox"/>	Irradiated sample using 26 GeV protons	1	Material	Other	Solid	2012.05.24 08:00:00	2012.08.22 12:35:15	
<input checked="" type="checkbox"/>	My 1st Package (Excepted)	10	Material	Other	Solid	2012.08.02 08:00:00	2012.08.22 11:13:16	
<input checked="" type="checkbox"/>	My 1st Package (Exempted)	150	Material	Other	Solid	2012.08.01 08:00:00	2012.08.22 11:02:28	
<input checked="" type="checkbox"/>	My 1st Package (Type A)	5	Material	Other	Solid	2012.08.03 08:00:00	2012.08.22 11:15:18	
<input checked="" type="checkbox"/>	Simple Package (Excepted)	1	Material	Other	Solid	2012.08.10 08:00:00	2012.08.22 11:23:31	
<input type="checkbox"/>	Spectro	1	Material	Other	Solid	2012.01.06 08:00:00	2012.08.22 13:11:36	
Total: 7								

Send to My Packages



e-Ship user interface: My 1st packages

In this first example, a package consisting 1 kBq of Cobalt-60 is created. The activity was reported on 1st Aug. 2012. Default package characteristics are assumed (material, solid, other form). In the nuclide table only the IAEA Transport values are shown for clarity. A host material mass of 150 g was set. The transport report can be generated by clicking on the Report button at the bottom of the page. The Report is shown in the following figure.



e-Ship

radiological transport assistant

My PackagesEditOptionsImportActivity limitsCERN fileSample packagesAbout e-Ship

Name (ID=86)

My 1st Package (Exempted)

Description:

Package contains the nuclide: Co-60 (1000 Bq);
This package was characterised on 1 August 2012 as Material, Other form and Solid.
Host mass is 150 g

Activity reported:

2012.08.01 08:00:00

Package characteristics

Source

☒ Material

Instruments / Articles

Form

☒ Other

Special

State

☒ Solid

LiquidGas

Host material: 150g

Nuclide	Activity A (Bq)	A ₁ (TBq)	A ₂ (TBq)	Excepted (GBq)	Exempt (Bq)	Exempt (Bq/g)	A/A ₂	A/Excepted	A (Bq)/Exempt(Bq)	A (Bq/g)/Exempt(Bq/g)	Delete
Co-60	1.00e+3	0.4	0.4	0.400	1.00E+05	10	2.50e-9	2.50e-6	1.00e-2	0.667	

e-Ship: nuclear material transport report

Transport report generated for source: My 1st Package (Exempted) by magilltest on Aug 30, 2012 14:11:01

Package name: My 1st Package (Exempted)
Description: Package contains the nuclide: Co-60 (1000 Bq); This package was characterised on 1 August 2012 as Material, Other form and Solid. Host mass is 150 g
Source: Material, Other form, Solid
Host material mass: 150 g

Source characterisation

Nuclide	Half-life	Mass (g)	Activity (Bq)	Heat (W)	Gamma dose rate H ₁₀ (μSv/h) at 10 cm
Co-60	5.27 y	2.39e-11	1.00e+3	4.16e-10	3.66e-2

Package characterisation

Nuclide	Activity (Bq)	Exempt (Bq)	Exempt (Bq/g)	Excepted (GBq)	A ₂ (TBq)	A	A(Bq/g)	A	A
						Exempt	Exempt(Bq/g)	Excepted	A ₂
Co-60	1.00e+3	1.00e+5	1.00e+1	4.00e-1	4.00e-1	1.00e-2	6.67e-1	2.50e-6	2.50e-9

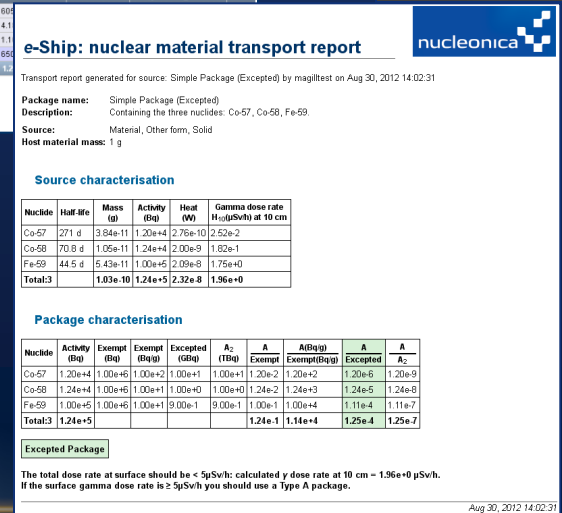
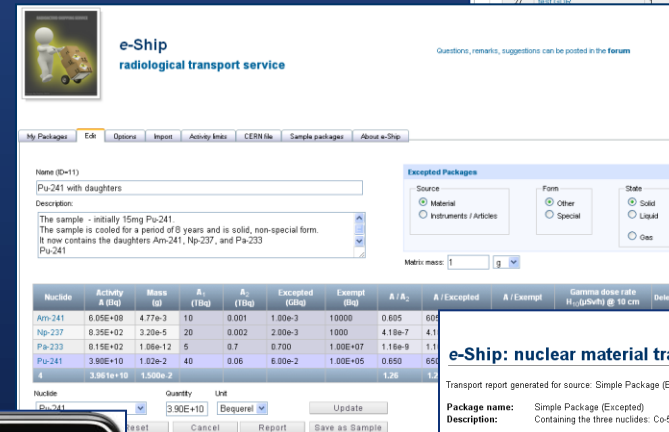
Package Exempt from regulation

The total dose rate at surface should be < 5μSv/h; calculated γ dose rate at 10 cm = 3.66e-2 μSv/h.
If the surface gamma dose rate is ≥ 5μSv/h you should use a Type A package.

Aug 30, 2012 14:11:01

e-Ship: radiological transport assistant

- What is e-Ship?
- Background information on nuclear transports
- e-Ship user interface:
 - My Packages
 - Edit, Report
 - Options
 - Import
 - Sample packages
- My 1st packages



Thank You!